SONOTONE CORPORATION
BATTERY DIVISION
ELMSFORD, NEW YORK 10523

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONTRACT NAS-5-9226

TECHNICAL STATUS REPORT NO. 14
(December 11, 1966 through March 31, 1967)

"PROCUREMENT AND DEVELOPMENT PROGRAM
FOR NICKEL-CADMIUM CELL TO
SPECIFICATION S-615-P-2"

I. SUMMARY: Specification changes were requested and granted for Item 1 cells and others were requested for Item 2 and 3 cells. Drawings and the CIL were revised. Improvements in plate testing equipment and procedures were made and minor changes in other areas are described. The Qualification Test for Item 1 cells was completed and some of the data are summarized. A Schedule is given together with present status for the cells of Item 2. Data are presented on air permeability of separator material before "roller" processing by DRTE and permeability after processing is discussed, Sonotone is preparing to use this method of increasing permeability. Meetings which were held are described. A Quality Assurance report and a copy of the log of significant quality events are included.

II. SPECIFICATION AND DESIGN:

A. Changes in the specification, applying to Item 1 cells, were received as Modifications 6, 7, 8, 10 and 11. These changes were those on which agreement was had at the meeting of February 1.

B. As discussed at that meeting and the meeting at NASA, GSFC of February 24, we sent, on March 16, a list of "Recommended Changes in S-615-P2", for cells of Items 2 and 3, together with the latest date on which decisions were needed so that the delivery schedule will not be affected. These dates range from April 1 to May 1.

C. On March 14, we issued a revised Conformation Identification List and accompanying drawings.

III EQUIPMENT AND FACILITIES:

A. The two "open cell test" units have been redesigned and are being rebuilt. The first unit was completed in March and several runs have been made which indicate that better yields of plates with satisfactory capacity are being obtained. The second unit is being reconstructed (see also Section VII) and we expect that it will be completed early in May.

SONOTONE CORPORATION
BATTERY DIVISION
ELMSFORD, NEW YORK 10523

April 12, 1967

National Aeronautics and Space Administration
Goddard Space Flight Center
Glenn Dale Road
Greenbelt, Maryland

Attention: Contracting Officer, Code 246

Gentlemen:

We are enclosing one copy of "Technical Status Report No. 14" covering the period of December 11, 1966 through March 31, 1967.

We are also sending copies to the others on the distribution list of Request No. 615-31914, modified by letter of December 19, 1966 (Code 246/CHM/mgb), as noted below.

Sincerely yours,

SONOTONE CORPORATION

George A. Baumstark

GAB:svb
Encl.

George A. Baumstark
Project Manager

cc: 1 to NASA, GSFC, Technical Information Division, Code 250
2 to NASA, GSFC, Technical Director, Code 615
2 to DRTE, Ottawa, Chief Superintendent
1 to RCA-Victor Company, Ltd., ISIS Spacecraft Department
1 to W. E. Threinen

B. Training of employees is being continued so that we have at least two people who are qualified and have DCAS certification to perform each operation. This is particularly important for such key and critical operations as "open cell testing", core assembly and welding operations.

C. To expedite the "open cell" test, we have arranged to have qualified operators present for approximately 10 hours each day so that a batch of plates can be processed each day rather than one batch every second day. At present, until a second certified operator is available, overtime has been authorized to accomplish this.

D. The plate handling, assembly and test equipment have been rearranged to give an improved flow and to facilitate the operations. Work benches, which have dust-free cabinets with filtered air under positive pressure, are being provided. The air-conditioning unit is being given a "summer-winter" temperature control for more uniform and closely regulated temperature. A vestibule, just inside the entrance, is being built, which will provide better shielding of the High Reliability area from the rest of the plant.

E. Storage of plates and core assemblies has been improved. When plates or assemblies, which are subject to carbon dioxide contamination, are not being actually used or tested they are stored, after wrapping in vinylidene chloride-vinyl chloride copolymer (Saran) film, in clear polystyrene boxes with tightly-fitting covers. The permeability to carbon dioxide is much lower for this Saran film than for polyethylene film which had been used. The permeabilities for the three materials, polyethylene, polystyrene and vinylidene chloride-vinyl chloride copolymer are 1000 to 6000, approximately 1000 and 12 cc/100 sq. in/24 hours/mil respectively.

IV. A. ITEM 1 CELLS

As agreed on November 15, 1966 (see Section III of Report No. 13) cells from the group Nos. 272 through 310 were submitted to Qualification Tests for delivery as Item 1 cells. These tests were completed on March 28 and ten cells were sent to the shipping department; the remaining nine cells were scheduled to remain at Sonotone as GFE for further tests to be authorized by NASA and DRTE. These cells were selected during the meeting of February 1 (see Section VI B 1).

Copies of the test data are being forwarded according to the contract. The data are briefly summarized here:

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Capacity at +25°C: 8.8 to 10.9 AH
Capacity at -5°C: 10.6 to 12.6 AH
Capacity at +40°C: 6.5 to 8.5 AH (1 cell at 6.5; 2 at 7.0; 1 at 7.1 AH)
Overcharge at -5°C: pressure, all constant at 120 hours, 5 above 150 psi; 2 between 100 and 150 psi; 13 below 100 psi. Voltage, 1 above 1.56, none above 1.58 volt.
"Pulse Test" (85 amperes): voltage after 10 seconds 0.756 to 0.958 volt
"Short Charge Retention Test": voltage after 24 hours, 1.183 to 1.204 with 5 above 1.20 volt; one cell (#309) failed, 0.06 volt at 24 hours.
Cell Weight (less adapter): lot average 451 grams, (Range 444 to 460 grams for the ten cells being shipped)

B. ITEM 2 CELLS:

1. Two lots of plaques and plates which we had planned to use for these cells were rejected. The first lot of cut plates (700 positive and 700 negative) processed in November and December 1966 could not be used because they were beyond our specified length, thickness and weight requirements. Because of thickness they could not be rolled to provide "cores" which would fit into the cell case, and the resultant weight, it was estimated, would result in cells whose lot average weight would be approximately 470 grams. This occurred in late January. The next lot of 160 positive plaques was found to be too heavy and thick on February 17.

2. A third lot of plaques (200 each positive and negative) was sintered and has been processed. This group (see Section VII Schedule) will give us sufficient plates to complete Lot 2 cells and approximately half of those needed for Lot 3 cells. An additional batch of 300 positive and 200 negative plaques was ordered on March 15 and is being sintered. These will give enough plates for Lot 4 cells.

3. Referring to the Schedule (Addendum 1) Lot 1 consists of 10 cells (Nos. 311 - 320) which contain plates similar to those used for cells 273 - 310. Agreement was obtained from NASA and DRTE to use these cells with separator which has been "roller-manipulated" to increase permeability (see Section V). Thus, we will have an earlier evaluation of the separator, about one month, than were we to wait for cells with new plates. We have also subjected plates (except those in cell 320) to another "open-cell" test which may reduce the carbonate content of electrolyte.

These cells, if they prove satisfactory on our screening test, Phase F, will be added to cells from Lot 2 for the Qualification Test.

4. Plates for the Lot 2 cells have completed processing, some are ready for open-cell tests and it is expected that enough will be tested to allow cell assembly to start during the week of April 10. If our yields in "open-cell" test are higher than those used in our estimates for the Schedule, we expect to be able to start more than 24 cells on Qualification Test. Since there may be 8 to 10 cells of Lot 1, we may very well obtain 36 to 38 cells in Lot 2, as the yield of the Screen Test (Phase F). This means that we may have as many as 30 to 32 cells as the final yield for Lot 2 in addition to approximately 8 cells from Lot 1.

V. SEPARATOR:

A. Since the cells from Nos. 273 - 310 which were made with separator which had been manipulated by hand gave overcharge characteristics (pressure and voltage) which were far superior to previous cells, it was decided to use separator whose permeability is increased to 80 to 120 CFM. It is very difficult to hold this range because the non-woven material is quite variable in permeability even within the area used in a single cell. A report by Mr. Paul Scardaville on separator variability is included as Addendum 2. As an example, there was permeability variability within a 6 inch x 5 foot sample measured on a 2 inch circle as great as 56 to 115 CFM on the material (before manipulation) being used for Lot 2 and 3 cells.- Bale 681019, Roll 6. Further, in the 6 rolls constituting Bale 681019, we find values between 41 and 147 CFM.

B. DRTE and DCBRL developed a method for treating the material by passing it between a heavily-knurled steel roll and a rubber roll of the type used in hand wringers for removing excess water from washed cloth. They offered to process material for use in the cells. On February 7, we sent 40 pieces each 6 inch by 5 feet and 31 of these were returned, with higher permeability, on March 7. There was such variability that it was found necessary to do selective treatment within each piece, as many as 300 "passes" being required. Due to this, there were some small areas that were quite "thin" as viewed against bright light and these were deleted. Each of these pieces, were there no "thin" areas which cannot be used, could be cut into 4 smaller pieces of the shape used in the cell so there would be 124 available which would be enough for 41 cells (3 pieces per cell). Due to the deleted portions, we obtained enough for approximately 30 cells.

Later, on March 10, 36 more pieces also taken from Roll 6 of Bale 681019 were given to Mr. G. Mackie for manipulation. These have been sent back but have not been received yet.

Data on permeability were sent us by DRTE. Our readings on these pieces are in general agreement considering the great variability even within small areas. For example, on these 2 inch circles taken within a 6 inch diameter area, we found variations as great as 115 to 170 CFM.

C. We now have, on loan, the knurled roll which was used and will assemble it in a wringer frame so that we will be able to increase the permeability of separator material at Sonotone. This should be ready for use within a few weeks.

Within two to three weeks we should have results of the "screen test" (including overcharge) on cells 311 - 320 made with this "processed" separator (see Section IV B3).

D. The question was raised during the February 1 meeting (see Section VI B1) as to the relative amounts of separator in the "F" cells of 1961 (35059-1) used in the Alouette Satellite and the present Isis cells (37805). We investigated this and find that they vary less than 10% as we stated at the meeting. Data are summarized thus:

		Alouette F	ISIS
Separator to plate volume	$\frac{\text{sq. in.}}{\text{cu. in.}}$	36	41
Separator to core assembly weight	$\frac{\text{sq. in.}}{\text{gram}}$	0.67	0.63
Separator to electrolyte weight	$\frac{\text{sq. in.}}{\text{gram}}$	3.94	3.68

VI MEETINGS

A. Sonotone

In addition to many meetings of people directly concerned with problems which arose, the following general meetings were held.

1. On January 11, 1967 to discuss the status and future prospects.

2. On February 23, preparatory to a meeting at NASA-GSFC concerning the schedule and financial matters.

3. On February 28, on the schedule and drawing changes.

4. Also on Feb. 28, a complete review was made of all drawings and the Conformation Identification List.

B. With Representatives of NASA, DRTE etc.

1. A Design Review Meeting was held at Elmsford with representatives of NASA-GSFC, DRTE, DCBRL and RCA-Montreal on January 31 and February 1, 1967. A summary of this meeting is attached as Addendum 3.

2. A meeting took place at NASA-GSFC on February 24 concerning schedule, financial matters and specification changes.

3. On March 1 and 2, Messrs. R. T. Schools of NASA and J.E.T. Tennuci of DRTE visited Cold Spring and Elmsford on Quality Assurance matters. The minutes of this meeting, prepared by Mr. S. Herzlich constitute Addendum 4 of this report.

4. On March 10, Mr. P. Scardaville and I met Messrs. E. D. Nelsen of NASA and G. Mackie of DRTE and Dr. T. E. King of DCBRL at the offices of American Felt Co. in Glenville, Conn. Properties of this non-woven polypropylene cloth and means to be taken to improve it for use as separator were the subjects of this meeting.

5. Later, on March 10, Messrs. Nelsen, King and Mackie visited us in Elmsford and were informed of what we were doing to improve the delivery schedule.

6. Through frequent telephone calls we have kept Messrs. G. Mackie of DRTE and E. D. Nelsen informed about the status of this project.

VII SCHEDULE

A schedule for the delivery of all remaining cells, Items 2 and 3, of this contract is attached as Addendum 1 together with the actual progress in the form of bars directly beneath the schedule bars. The bars are different so that the successive phases can be separately identified as to their initial and final date. Thus, the schedule bars are alternately "solid" and "interrupted" solely for the purpose of separation.

The operations starting with sintering and ending with completion of the Qualification Test are divided in eleven phases, denoted A thru K. These are summarized at the right margin of the schedule sheet and are given in greater detail here.

A. Sintering. This includes tests of thickness, weight and porosity, coining, special coining, resintering, welding of tabs and visual inspection.

B. Plaque Processing. This includes impregnation with active material, formation as plaques and several weighing and inspection operations.

C. Preparation of Plates for open cell testing including cutting, welding of tabs, weighing and inspection.

D. Open Cell Testing which includes assembly with separator and plate of opposite polarity, checking for "shorts", charging, discharging, washing of plates, drying, weighing and inspection.

E. Assembly which starts with selection of positive and negative plates according to capacity and weight to provide cells which will meet weight, weight range, capacity, capacity range and negative-to-positive capacity ratio. The plates are then rolled with separator material, the tabs are welded to cover and case, insulators are inserted, the cover is welded in place. There are several inspection operations and component weights are recorded.

F. Screen Test. This includes several charge-discharge cycles interspersed with electrolyte carbonate determination and "flushing" with fresh electrolyte to lower the potassium carbonate content to below 4.0%. From 6 to 9 charge-discharge cycles are anticipated. This is then followed by an overcharge at -5°C for at least 40 hours with readings of cell voltage and pressure.

G. Qualification Test. This initial portion covers Examination of Product, and three charge-discharge cycles at +25°C.

H. Qualification Test. This is the 120 hour overcharge test at -5°C.

J. Qualification Test. This phase includes three charge-discharge cycles at both -5°C and +40°C.

K. Qualification Test. This phase includes sealing of cells, electrolyte leakage test, vibration, acceleration tests, X-ray examination, high rate discharge (pulse) test and the charge retention (voltage after "short" and minimum charge) test.

Within boxes at upper center and lower center are given the numbers of cells, plates or plaques which are the "input" and "output" of the several phases. The upper box covers Lot 2 where extra plates are provided to enable selective assembly to be made to meet the weight, weight range, capacity, capacity range, and negative-to-positive capacity ratio. In order to arrive at these we have used yields for the various phases based on our experience.

There are two critical phases which govern the schedule: 1) "D" open cell test and 2) those phases which require an environmental chamber and pressure measuring and recording equipment, the last 3 days of F, (called F^1) as well as G. through J.

With the assistance of NASA - GSFC in procuring components, we expect to be able to have a second "open cell" unit in operation by early May so that this phase will no longer be a "bottle-neck", and we will have this facility available for other "space-cell" orders.

The need for environmental chamber and associated equipment during the approximately 4½ week period called for by Specification S-615-P-2 means that no other orders can be handled during the next six months. Sonotone Corporation is providing for additional equipment to handle these other commitments.

According to this schedule, assuming our estimated yields, etc. are correct, we should complete the order about November 20. Another schedule has been prepared, but is not included with this report, based on a third set of the critical Qualification Test equipment (cost $25,000.) being available about July 15. This, we estimate, will move up the final completion date from November 20 to October 26 or approximately four weeks. Sonotone Corporation is not in a position to procure this third set of the environmental, pressure, etc. equipment.

It will be noted that Lot 1 consists of cells 311 through 320 which are being assembled from plates processed in 1966. Plaques for Lots 2, 3, etc. will be processed as required. The quantities indicated are based on the assumed yields and may be less or greater depending on actual yields. All these cells will be assembled with separator material which has been mechanically manipulated according to the technique evolved by DRTE and DCBRL. We expect this material to give results equal to those obtained with cells 273 through 310 made with "hand manipulated" separator and being delivered as Item 1 cells. Cells 311 - 320, Lot 1 of this Schedule, constitute a test of this expectation. These cells will be carried through phase F and then will be held for Lot 2 and carried through the Qualification Test with cells of Lot 2.

We wish to point out that Lot 2 may very well be greater than 20 cells, provided the yield in open cell test (Phase D) exceeds what was used in our estimates. The maximum we would expect is 40 cells for Lot 1 plus Lot 2.

VIII QUALITY ASSURANCE

A. Minutes of the meeting with Messrs. R. T. Schools of NASA and J.E.T. Tennuci of DRTE are included as Addendum 4.

B. A report by Mr. Myron Karsevar, the Quality Control supervisor for the High Reliability unit on Quality Assurance and Quality Status is included as Addendum 5.

C. A log of significant quality events has been kept since March 6. Copies of this for March appear as Addendum 6.

D. A report on permeability of separator material is discussed in Section V. A and forms Addendum 2.

E. The revised CIL and drawings were issued on March 14.

F. The matter of plate and core assembly storage is discussed in Section III E. It is our opinion that this method is superior to the use of an inert atmosphere. Since carbon dioxide is present in such small concentration in air ...0.03 to 0.07% ... there will be only very little increase of carbonate in plates if we use a double container using materials which have very low permeability to carbon dioxide. This a simpler method and one equally as effective as storage in an inert atmosphere such as dry nitrogen.

G. The operations and general house keeping have been greatly improved. (See also Section III D). Electrolyte storage also has been improved with carbon dioxide absorbers on the air-inlet tubes to the storage bottles.

H. We have given careful consideration to the use of the helium leak test and have decided that since we perform it shortly after introducing helium, it is a valuable adjunct to the indicator test for electrolyte leakage and we will continue to use both tests.

IX COULOMETER

Ten coulometers, Nos. C101 through C109, were assembled and tested in January and February. The tests included three cycles of charge and discharge at 25°C, 40°C and -5°C. At this point the capacities did not meet the requirements of the specification at -5°C, although they had been satisfactory at the higher temperatures. They were from 8 to 9 AH whereas the specification cells for 10 AH and were only about 60% of that obtained at 25°C.

It was felt that perhaps the "formation" step as coulometers had not been properly done and they were given to engineers in the R and D group who have been working on coulometers. We believe that the difficulty is due to the separator, a sandwich of woven nylon cloth and separator, and the small amount of space above the plate assembly which do not allow sufficient electrolyte to remain in the cell to fully cover the plates.

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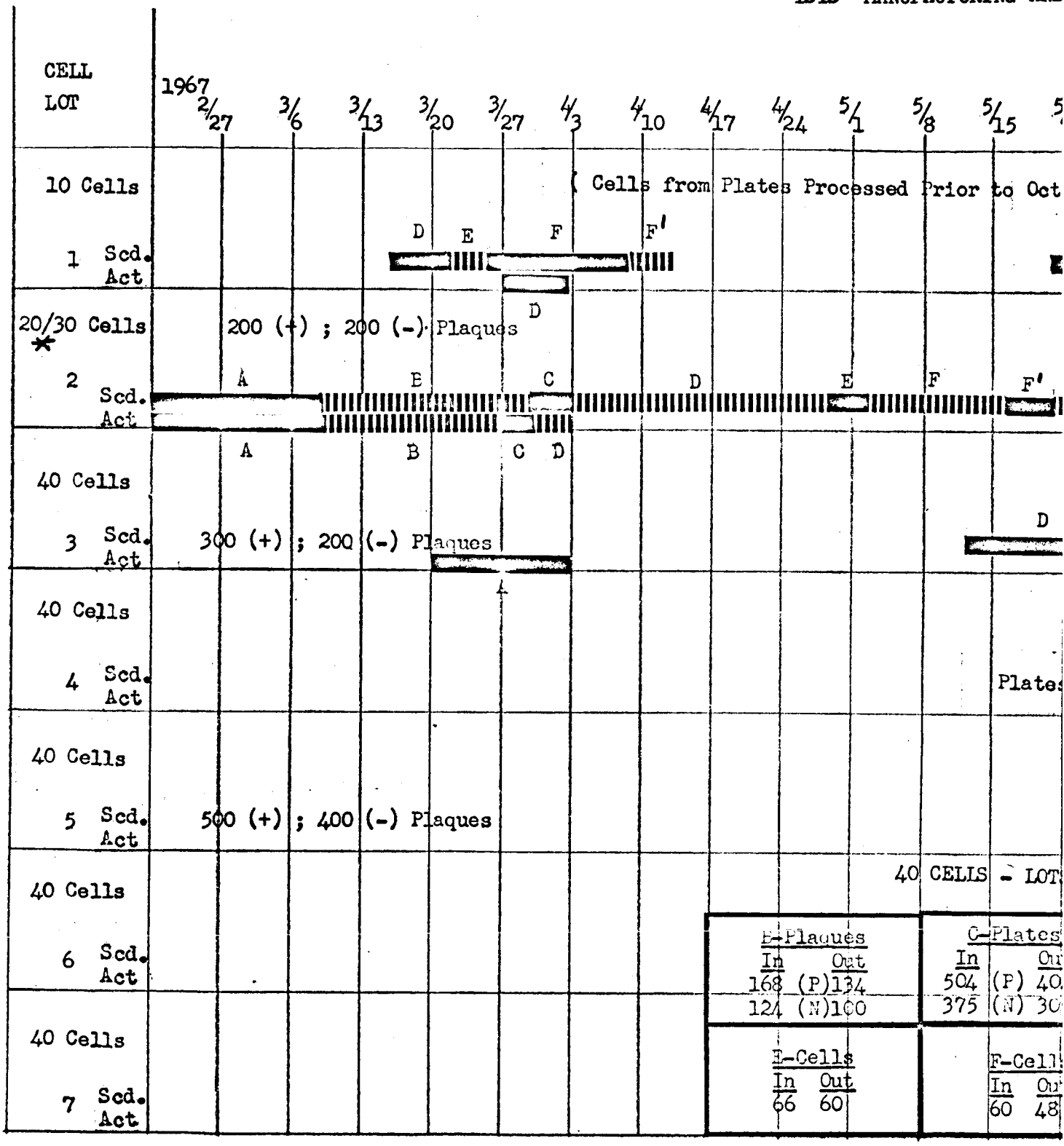
Due to this, the cells did not operate as coulometers but more like a sealed cell, since only minor amounts of gas were evolved on overcharge. Also, the plates used in these coulometers were taken from the same lot as those used for cells 100 through 135 which were originally intended to be delivered as Item 1 cells. Due to the difficulties encountered with pressure and voltage on the -5°C overcharge test with these cells, they did not meet the tests and cells in the group 273 through 310 are Item 1 cells.

Consequently, plates of the same group used in these cells (Nos. 273 - 310) have been retested (open cell) and will be used for the Item 1 coulometers. Some of the plates will be used to make approximately 15 cells with three types of separator for a test to determine which separator will enable us to make satisfactory coulometers. The separators used will be: nylon woven cloth and cellophane, non-woven polypropylene cloth and non-woven nylon cloth. The woven nylon and cellophane is the same as was used for coulometers C101 to C109 described above and the non-woven materials have been used in making three types of cylindrical, sealed coulometers, which have performed satisfactorily.

George A. Baumstark

"ISIS" MANUFACTURING AND

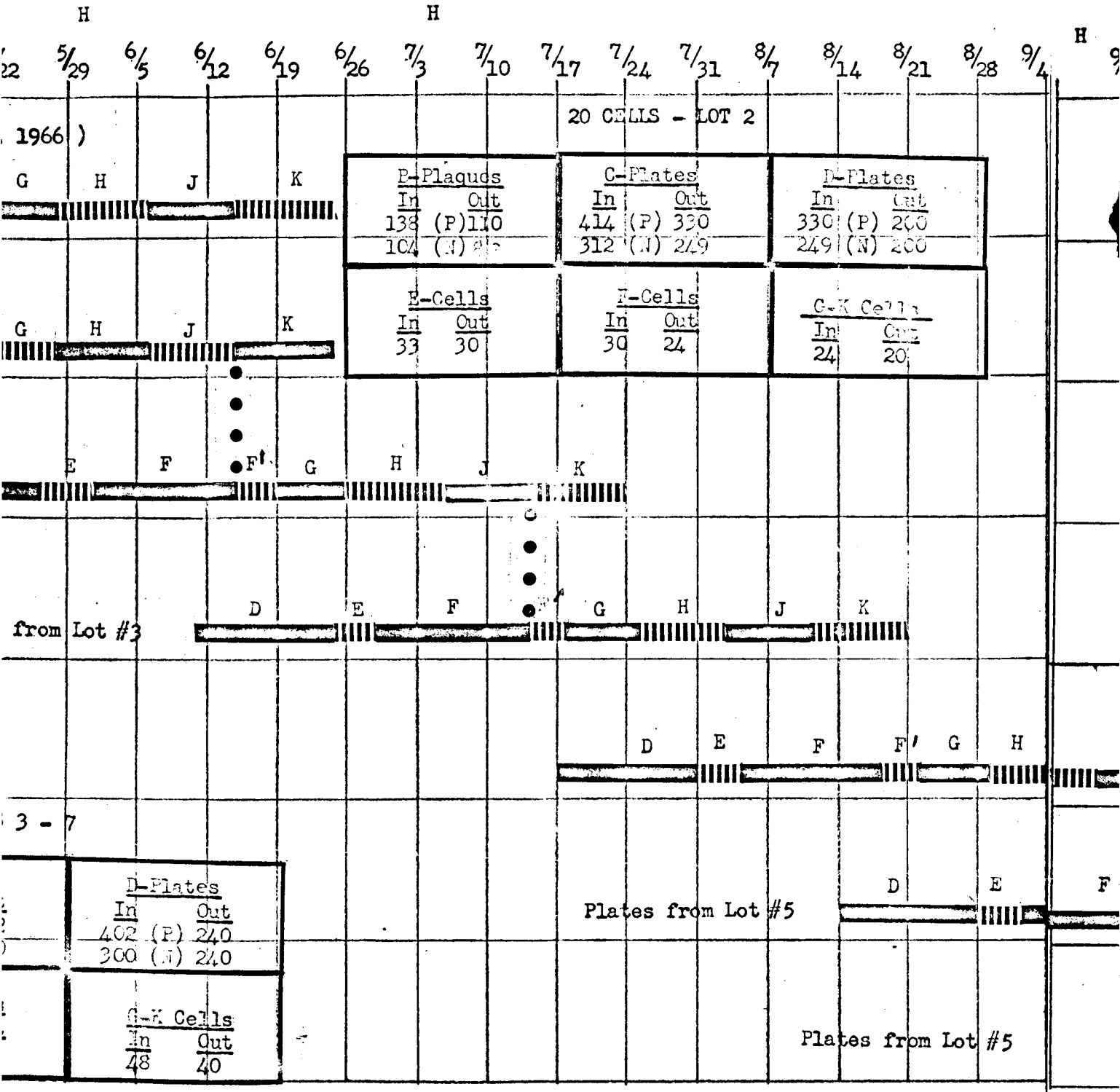


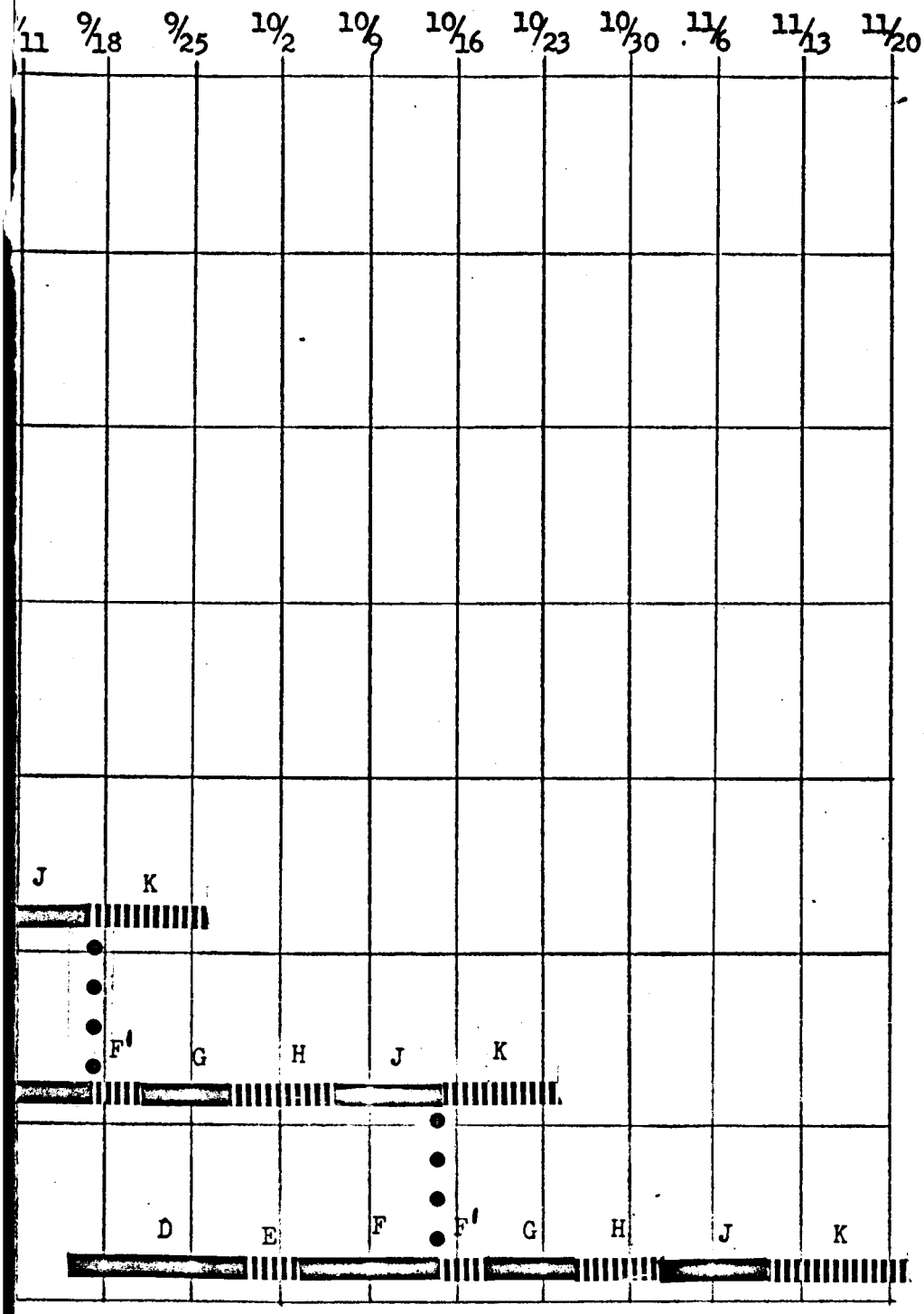
* Depending upon yield on Open Cell Test.

E C O R P.

TEST SCHEDULE (WEEKLY)

1.-Present Qual. Test Equipment.
2.-Open Cell Test-(48) plates/batch at present.
(96) plates/batch-approx. May 15.





OPERATIONAL CODE

A-SINTER PLAQUES

B-PROCESS PLAQUES

C-PLATE PREP.

D-OPEN CELL TEST

E-ASSEMBLY

F-SCREEN

F'-SHORT OVER-CHARGE TEST

G-QUAL. TEST

H-QUAL. TEST (OVERCHARGE)

J-QUAL. TEST

K-QUAL. TEST (FINAL)

MARCH 31,1967
ADDENDUM # 1

SONOTONE CORPORATION

To G. Baumstark
S. Herzlich
A. B. Mundel

Date April 11, 1967

From P. Scardaville

Subject Sampling of American Felt Polypropylene Felt Available for Use in ISIS Program

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Discussion

There are fifteen (15) rolls of polypropylene on hand in the High Reliability area. A five foot long sample strip was cut from the same position of each roll and identified by an assigned roll number. All but 2 rolls were also labeled by the manufacturer as to the bale number of the polypropylene fiber that was used to produce it.

The air permability at 0.5" H_2O of each sample was measured in three places designated A, B, and C. These were randomly selected, but approximately are located at the beginning, middle and end of each sample strip. The thickness was measured in three places across the area whose air permeability was measured. A Federal dial micrometer gauge having a 0.5" diameter pressure foot was used without the use of an additional weight. The weight of a 3" x 3" square cut from each area where the air permeability was measured was recorded.

These data are listed in Table 1.0. Table 2.0 lists the variability in parameters according to bale number. Table 3.0 lists the average variability in parameters. It may be readily seen that the variations within some rolls are of the same order as the variation from roll to roll and bale to bale.

Conclusion

The variability is so great that it is doubtful that any roll is preferable to another in this regard.

Materials selected for roller-treating to increase air permeability should be taken from rolls of the same bale number to assure uniform chemical composition. They should be further selected by means of air permeability measurements to group them as closely as possible, eg: $x \pm 20 CFM/ft^2$.

Table 1.0

Bale	Roll	Air Permeability CFM/sq ft @ 0.5"H_2O		Wgt of 9sq in	Thickness (mils)		
681019	1	A	65	0.5370	12.2	11.1	12.9
		B	80	0.4825	10.7	10.7	9.5
		C	56	0.5270	12.7	11.3	10.2
681019	2	A	132½	0.4410	11.8	13.5	12.3
		B	133	0.4525	11.2	10.9	12.1
		C	147	0.4425	11.6	11.2	12.1
681019	3	A	56	0.5200	12.4	11.6	11.8
		B	75½	0.5140	10.5	11.6	11.5
		C	41	0.5760	11.7	12.2	11.6
681019	4	A	86	0.4775	9.7	10.2	10.2
		B	57	0.4915	9.8	10.2	9.6
		C	122	0.4590	11.7	12.0	11.8
681019	5	A	75	0.4865	12.0	11.2	11.2
		B	75	0.4695	10.8	12.0	11.7
		C	86	0.4755	12.5	12.5	12.3
681019	6	A	115	0.4855	12.5	12.5	13.2
		B	56	0.5045	10.5	10.2	10.5
		C	72	0.5010	10.9	10.7	11.8
39304	7	A	20	0.5405	9.3	9.3	9.3
		B	30	0.5380	10.4	10.7	10.4
		C	35	0.5580	14.0	11.5	12.0
39304	8	A	48	0.5070	9.9	10.6	10.5
		B	47½	0.5240	10.8	10.7	12.0
		C	45	0.4950	10.6	12.5	13.8
39304	9	A	51	0.4610	9.9	9.9	9.9
		B	32	0.5600	10.0	9.9	10.0
		C	25	0.5105	9.8	9.9	9.9
39815	10	A	66	0.5915	13.4	15.2	12.2
		B	30	0.6190	12.5	12.7	12.5
		C	66	0.5060	11.2	11.1	11.1
39269	11	A	27	0.4900	9.9	9.9	9.8
		B	55	0.4955	9.9	9.9	9.9
		C	48	0.5005	10.0	10.0	11.1
39336	12	A	128	0.4615	10.0	10.0	10.0
		B	100	0.4895	10.0	10.0	9.9
		C	98	0.4705	9.9	9.9	9.9

Table 1.0 (Continued)

Bale	Roll	Air Permeability CFM/sq ft @ 0.5"H_2O		Wgt of 9sq in	Thickness (mils)		
68947	13	A	128	0.4230	11.2	13.0	10.5
		B	100	0.4605	10,8	10.7	11.0
		C	98	0.4730	10.0	12.8	12.9
none	X1	A	40	0.5000	10.0	12.0	11.3
		B	70	0.5500	12.5	11.4	11.1
		C	71	0.5640	13.0	13.3	10.6
none	X2	A	32	0.5125	9.5	10.0	9.7
		B	75½	0.4955	10.5	11.2	12.0
		C	40	0.4470	9.2	9.5	9.2

Table 2.0

Range of Parameters According to Bale Numbers

Bale #	Thickness mils	Air Permeability @ ½" CFM/ft^2	Wgt/9 in^2 gms
*681019, (6 rolls)	9.5 - 13.5	41 - 147	0.4410 - 0.5760
68947, (1 roll)	10.0 - 13.0	98 - 128	0.4230 - 0.4730
39304, (3 rolls)	9.3 - 14.0	20 - 51	0.4610 - 0.5600
39269, (1 roll)	9.8 - 11.1	27 - 55	0.4900 - 0.5005
39336, (1 roll)	9.8 - 10.0	98 - 128	0.4615 - 0.4895
39815, (1 roll)	11.1 - 15.2	30 - 66	0.5060 - 0.6190

*Impounded for ISIS

Table 3.0

Overall Range of Parameters

Thickness	Air Permeability @ ½"	Wgt/9 in^2
9.3 - 15.2 (mils)	20 - 147 CFM/ft^2	0.4230 - 0.6190 gms

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ELMSFORD, NEW YORK 10523

SUMMARY OF ISIS REVIEW MEETING OF JAN. 31 AND FEB. 1 AT ELMSFORD & COLD SPRING, N.Y.

I Attended by:

A. On January 31 by Dr. T. E. King of DCBRL; Messrs. H. R. Raine, G. H. C. Mackie of DRTE; Mr. R. McCubbin of RCA-Montreal; and Messrs. P. Scardaville, E. Shields and G. Baumstark of Sonotone.

B. On February 1, in addition to the above-mentioned (except for Mr. Scardaville), Mr. W. E. Threinen of DRTE; Mr. E. D. Nelsen of NASA-Goddard; Messrs. J. A. Stewart, A. B. Mundel, L. Belove, E. F. Murphy and F. Crozier of Sonotone.

II Meetings:

A. On January 31, at Elmsford, Dr. King and Mr. Mackie reviewed the information obtained from the manufacturer of the non-woven polypropylene separator material (American Felt Co.) and the fiber manufacturers (Dow, Reeves, Hercules) chiefly with respect to the additives present in the separator (No. 305) which was used for the "F type" cells made in 1961 for the "Alouette" satellite. Some of these cells gave satisfactory performance in laboratory tests and subsequently in the Alouette spacecraft. No internal cell pressure measurements were made with these cells but they did not deform (indicating pressures below approximately 400 PSI). The primary criterion for satisfactory performance was low (below 1.5 volts) and steady voltage on low temperature overcharge.

A number of additives are used in the manufacture of the material, some to improve processing, either of fiber and of cloth and probably some to improve properties for other uses of the material. There is a great deal of uncertainty here, both as to the additives used, although we know something of their general nature, and to changes in these materials that are made from lot to lot and even within lots.

In addition to the information from the supplier, Dr. King summarized the work done by DCBRL and Mr. Scardaville described the work done by Sonotone on isolation of the materials present in the separator. A sample of material from which 16% of the material was removed by solvent extraction was shown. Two samples of separator which had been mechancially manipulated between a corrugated roller and a rubber roller by DRTE were also examined.

Later, at Cold Spring, the permeabilities were measured. The solvent-extracted cloth was too weak, physically, to use for cell assembly and the permeability was above 500 CFM (measured at 1/4 inch water pressure). The samples of "roll manipulated" cloth varied between 80 and 120 CFM (at the standard 1/2 inch of water) within two pieces, each slightly less than 1 sq. ft. area.

The meeting was continued at Cold Spring. Attempts were made to remove sufficient electrolyte for carbonate analysis from two cells of the Alouette type by centrifugation. The amount removed was not sufficient. The operations and equipment of the High Reliability Laboratory were explained including Quality Control Functions. A short tour of the plant was also made.

B The Meeting Was Resumed on February 1, 1967 at Elmsford.

1. The matters covered the preceding day were summarized. Further discussion of the separator took place. It was agreed that changes in separator, of unknown nature and beyond our control, are responsible for the performance (on overcharge at -5°C) compared with satisfactory Alouette cells. DRTE representatives were of the opinion that the separator "additives" may be responsible for some of the carbonate present in the electrolyte. We stated that most of the carbonate is derived from the plates. The results of the last group of cells (between #277 and 311), made with separator hand manipulated to permeabilities of 80 to 150 CFM, on both overcharge tests (the screening test and the Qualification test)

were a great improvement over earlier work. The pressures were above 100 PSI in many cells but on all except two cells, the pressure did not rise appreciably after 48 hours of the 120 hour test; the voltages, however, were in many cases above the specification and did not correlate with pressure. The results of the overcharge after "flushing" of cells and reduction of carbonates where the pressure increased somewhat and the voltage decreased indicate that perhaps one of the additives in the separator, which is also a wetting agent, might be partially removed by "flushing" and thus change the cell characteristics unfavorably. It was agreed that the effect of addition of a wetting agent after "flushing" should be studied. The attainment of low electrolyte carbonate without flushing would be desirable and Sonotone people agreed that this might be done by special treatment - minimum wait between operations - during processing of plates. Plate washing after processing has not proved uniformly successful whereas, in three or four instances, Sonotone has made vented cells with K_2CO_3 below 3% by "minimum delay" processing.

We regularly store plates and core assemblies in polyethylene bags or closed plastic containers with a desiccant between operations. The matter of permeability of polyethylene to CO_2 and water vapor as well as presence of plasticizers, etc. was broughtup. We believe there are no plasticizers in polyethylene but CO_2 permeability will be checked.

2. With respect to other differences between Alouette and Isis cells: the rolling operation, and resulting tension is not greatly different; the amount of separator relative to plate or electrolyte volume may have been slightly less for the Alouette cells but within 10%.

3. Mr. J. A. Stewart pointed out that Sonotone has put much more money into this contract - approximately $80,000 to date - than the contract price which is $48,000 and could not continue on this basis without some financial relief.

4. It was agreed that 20 cells of the group (cells 277-311) which have completed part of the Qualification Test will be accepted, on waiver, pending completion of the test - mainly X-Ray, vibration and acceleration tests. The waiver from NASA-Goddard will call for pressure and voltage on overcharge, capacity at +40°C, capacity range at all 3 temperatures, cell weights etc. so that these cells will conform. A permanent specification change will be made from the present 2% maximum K_2CO_3 to 4%. Ten cells will be delivered to RCA, Montreal as soon as these tests are completed and the waivers received. The other cells will remain at Sonotone as GFE for further tests to be agreed upon between DRTE, NASA and Sonotone, such as addition of wetting agent, change of amount of electrolyte, etc. Of the 10 cells to be delivered to RCA, the 8 which have been "flushed" once shall not be "flushed" again before shipment; also 8 will be shipped sealed, and 2 will be shipped with pressure adapters.

5. Mr. H. Raine stated that the next shipment of cells was required no later than June, 1967 and that there were 51 cells needed for the spacecraft. Cells can be tested in groups of 48 with a test period of about 2 months with our present equipment. Mr. E. D. Nelsen asked what additional test equipment was needed to increase the test capability and was told that an environmental chamber, fixtures, transducers, and two recorders.

6. The relative merits of the size of the next cell lot to meet this schedule was considered (whether 24 or 48). It was decided to use 24 (actually 30 or more to give 24 for Qualification Test) with plates for a like quantity to be prepared so that cells can be assembled as soon as we have results of the -5°C overcharge on the first group. This will be done in such a manner that there will be a minimum of delay between the completion of the "open cell" test and core assembly.

The separator for these cells will be from a roll set aside for Isis cells which will be sent to DRTE where it will be "manipulated" on their "special" rolls which are 8 to 10 inches width. The exact width that can be handled will be given us by Mr. G. Mackie. Plates which were processed recently will be used. Since these are similar to previous lots in time elapsed in processing,

etc. we expect that the electrolyte carbonate content of the cells will be above 4% as assembled. From the plate weights (sample of the lot) we expect that the average weight for this lot of cells will be about 21 grams above the specification 450 grams and 8 grams above the 464 grams. (Mod. No. 1 of 3/28/55 and DRTE Telfax of 2/16/66 for Item 1 and 2 cells).

There was general agreement that the additive materials present in the separator and the nature of the separator is a major factor in cell performance especially on overcharge and that little is known about this at present. Furthermore, this is an area in which major improvements could be made. However, within the time schedules for delivery of these cells we cannot do this and must use the best knowledge we have now which is -- physical manipulation of the separator.

7. The matter of where the "flushings" will be done to meet the revised 4% K_2CO_3 requirement was made clear. All agreed that this will be done during the Sonotone test before start of the Qualification Test. Assuming two such treatments, with 3 charge-discharge cycles before and after each treatment, are required this will increase the pre-Qualification Test period to two weeks. Should a third be needed, this means an additional week.

8. Mr. Crozier brought up a number of specification changes which will clarify matters between our Q.C. Department and Mr. G. LeFloch, the DCAS representative having to do with details of testing. Some of these changes have been requested by our Q.C. Department and are being processed by DRTE and NASA.

Arrangements will be made by Mr. Nelsen with DCAS so that minor changes and waivers can be handled more quickly.

9. The status of the coulometer program is that the first group of 10 is on test and we expect to deliver 6 approximately March 1, 1967.

SONOTONE CORPORATION

To Those Listed **Date** March 2nd, 1967

From S. Herzlich

Subject Minutes of ISIS Meeting: March 2nd, 1967

Those Present: Mr. Schools - NASA, Quality Engineering
Mr. Tennuci - DRTE, Quality Engineering
Mr. Mundel
Mr. Herzlich
Mr. LeFloch

Summary:	Action by:
1. In order to improve communication between Sonotone, DCASR, NASA and DRTE, Mr. Schools requested that we furnish Mr. LeFloch copies of all pertinent letters and technical reports issued for the ISIS program.	E. Murphy
2. It was agreed that the periodic technical report shall include an addendum devoted to Quality Assurance and the Quality Status of ISIS cells. The report should be prepared by the Quality Assurance supervisor.	Dr. Baumstark
3. Mr. Schools requested that we maintain a log book of significant quality events. He suggested that a copy of each page be made and forwarded to NASA and DRTE at regular intervals. Entries to the log could be made by Quality Assurance supervising personnel and the DCASR representative.	Herzlich to initiate with Crozier
4. In order to determine whether there exists a significant difference in the permeability of polypropylene separator material for ISIS cells, it was suggested that a permeability test be made on samples taken from each of the six rolls impounded for this program. It was reported that the polypropylene sent to DRTE was taken from a single roll. A summary of test data is requested within ten days.	P. Scardaville
5. Both DRTE and NASA request an updated CIL , copies of the latest drawings and Quality Specifications listed on the CIL. We have been asked to comply within ten days.	Dr. Baumstark and E. Murphy

SONOTONE CORPORATION

To Those Listed Date March 2nd, 1967

From S. Herzlich

Subject Minutes of ISIS Meeting Cont'd. Page 2

	Action by:
6. It was suggested that an investigation be made to determine a procedure for storing plaques in an inert environment (such as dry nitrogen) in an effort to minimize the carbonate concentration in cells. In addition we were asked to describe existing procedures which can minimize the carbonate concentration in cells.	Dr. Baumstark
7. We were asked to consider an investigation of improved procedures for storing electrolyte in order to inhibit the carbonate concentration.	Belove to assign
8. Housekeeping in the High Reliability Department was considered to need improvement. A concentrated effort is required.	W. Miller D. Woodbury
9. We are required to comment on the advisability of continuing to perform the helium leak test on completed cells.	S. Herzlich